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NATIONAL DAM SAFETY PROGRAM. AUSTIN HARRISON DAM (MO 20219), VE--ETC(U)
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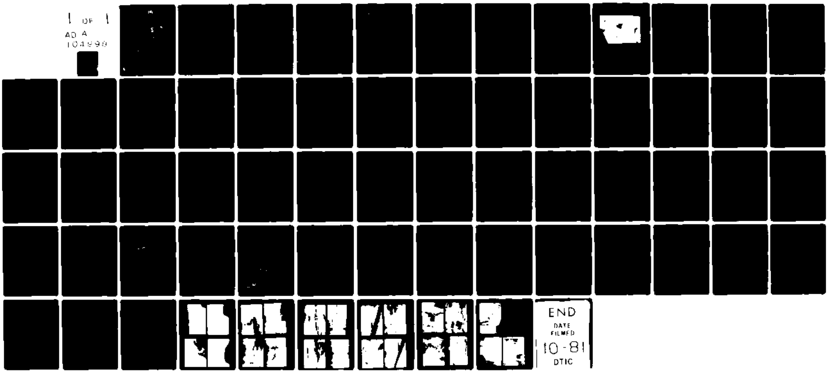

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ISTIN HARRISON DAM

WTON COUNTY, MISSOURI

MO 20219

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER, 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Austin Harrison Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Austin Harrison dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED 19 SEP 1979
Chief, Engineering Division — Date

APPROVED BY: SIGNED 19 SEP 1979
Colonel, CE, District Engineer — Date

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AUSTIN HARRISON DAM

NEWTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20219

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by

Anderson Engineering, Inc. Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction of

St. Louis District, Corps of Engineers

For

Governor of Missouri

September, 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Austin Harrison Dam
State Located:	Missouri
County Located:	Newton County
Stream:	Tributary Lost Creek
Date of Inspection:	20 June 1979

Austin Harrison Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 2 miles downstream of the dam. Located within this zone are one highway bridge, 15 dwellings, 2 buildings, and a railroad. Upstream from the dam 0.3 miles is a 28 ft. high earthen dam. The Austin Harrison Dam is in the small size classification since it is greater than 25 feet but less than 40 feet high and the maximum storage capacity is greater than 50 acre-feet but less than 1000 acre-feet.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 28 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be

expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering that 15 dwellings lie within the damage zone, the PMF has been determined to be the appropriate spillway design flood. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being equalled or exceeded in a given year.

The embankment appeared to be generally in good condition. Deficiencies visually observed by the inspection team were: (1) Brush and small trees on the downstream face of the dam; (2) A border of trees on either side of the crest; (3) Seepage at the west abutment contact; (4) Concrete in spillway is broken and undermined; (5) Trash fence in primary spillway has failed; (6) Primary spillway pipes are clogged with debris.

Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action in the near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

John M. Healy
John M. Healy, P.E.
Hanson Engineers, Inc.

Gene Wertepny
Gene Wertepny, P.E.
Hanson Engineers, Inc.

Steven L. Brady
Steven L. Brady, P.E.
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John Renner
John Renner, EIT
Anderson Engineering, Inc.

Tom Beckley
Tom Beckley, P.E.
Anderson Engineering, Inc.

AERIAL VIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

AUSTIN HARRISON DAM ID No. 20219

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APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Austin Harrison Dam in Newton County, Missouri.

B. Purpose of Inspection:

The purpose of the inspectior was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

The Austin Harrison Dam is an earth fill structure approximately 35 ft. high and 210 ft. long at the crest. The appurtenant works consist of 3 - 12 inch diameter steel pipes (1 with a 4 inch gate valve) located within the overflow spillway in the east abutment. The overflow spillway is part of the earthen embankment to the pipe outlets at which point the spillway is riprapped with field rock and the joints filled with concrete. Sheet 3 of Appendix A shows a plan, profile and typical section of the embankment.

Immediately downstream from the dam is an abandoned swimming pool. All spillway flow from the dam flows into

the pool. Piping installed with the pool includes a 12 inch diameter filtering pipe (filter removed), a 5 inch diameter pipe with gate valve tapped to an underground spring used to provide a constant source of water to the pool and a 12 inch diameter pipe with gate valve to provide for rapid drawdown of the swimming pool.

The upper dam is an earth fill structure approximately 28 feet high and 250 feet long at the crest. The appurtenant works consist of a 21 inch CMP spillway pipe with gate valve that has been covered with debris and 3 - 18 inch diameter steel pipe in the west abutment. Sheet 4 of Appendix A shows a plan, profile and typical section of the upper embankment.

B. Location:

The dam is located in the center west part of Newton County, Missouri on a tributary of Lost Creek. The dam and lake are within the Racine, Missouri 15 minute quadrangle sheet (Section 10, T25N, R33W - latitude 36°53.8'; longitude 94°32.0'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 35 ft. and a maximum storage capacity of approximately 144 acre-ft., the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 2 miles downstream of the dam. Located within this zone are one highway bridge, 15 dwellings, 2 buildings, and a railroad.

E. Ownership:

The dam is owned by Mr. Thomas Cusack, Sr. The owner's address is P. O. Box 818, Joplin, Missouri 64801. The owner at the time the dam was constructed was Mr. Austin Harrison. His current address is 110 Cochitrate Road, Walyard, MA 01778.

F. Purpose of the Dam:

The dam was constructed primarily for recreational purposes.

G. Design and Construction History:

No design information or plans are available. The information that follows on the construction stages was obtained from Mr. Austin Harrison, who was the owner of the property during the dam construction. The first dam built across the valley was a concrete dam 8 feet high. The dam that now exists on the site was completed in 1957. The material for the embankment was taken from the lake area. Construction on a second dam upstream was started but was abandoned after a flood severely damaged it. The owner stated that overtopping of the Austin Harrison (lower) dam appeared imminent during this flood and that he cut a V notch in the embankment to lower the water level. The upstream dam that now exists was completed in 1960. The owner indicated that the water level in the upper lake has never reached the spillway (maximum level 3 feet below spillway) and that the level is self regulating by flow into a cave within the upper lake area. He stated that the flow that goes into the cave does not appear in the lower lake. After construction of the second dam, the lower dam has never been overtopped. The water level in the lower lake does not vary according to all owners. To our knowledge, no modifications have been made on the dam since this construction was completed. The swimming pool complex at the toe of the Austin Harrison Dam was apparently built prior to 1960.

H. Normal Operative Procedures:

All flows are passed through the steel spillway pipes in the east abutment. The owners have indicated the water level remains essentially constant at normal pool level, with continuous flow derived from the two springs within the lake. Most of the surface runoff is contained by the upper dam. The maximum pool for the upper lake to date has been observed to be 3 feet below the spillway pipes. The upper lake level is maintained by an apparent cave within the lake boundary and evaporation.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 185 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through uncontrolled spillway.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 103.5): 443 cfs

(3) Estimated Capacity of Primary Spillway: 14 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: 314 cfs

(5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(7) Gated Spillway Capacity at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

(1) Top of Dam: 103.5 Feet (Ave.)

(2) Principal Spillway Crest: 99.0 Feet (Pipe Invert)

(3) Emergency Spillway Crest: 101.0 Feet (Depressed Roadway)

(4) Principal Outlet Pipe Invert: 99.0 Feet

(5) Streambed at Centerline of Dam: 68.5 Feet (Estimated)

(6) Pool on Date of Inspection: 100.06 Feet

(7) Maximum Tailwater: Unknown

(8) Upstream Portal Invert Diversion Tunnel: Not Applicable

(9) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Top of Dam: 1410 Feet

(2) At Principal Spillway Crest: 1400 Feet

(3) At Emergency Spillway Crest: 1400 Feet

E. Storage Capacities:

(1) At Principal Spillway Crest: 90 Acre-Feet

(2) At Top of Dam: 144 Acre-Feet

(3) At Emergency Spillway Crest: 114.0 Acre-Feet

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 10 Acres

(2) At Top of Dam: 14 Acres

(3) At Emergency Spillway Crest: 12 Acres

G. Dam:

(1) Type: Earth Fill

(2) Length at Crest: 210 Feet

(3) Height: 35 Feet

(4) Top Width: 22 Feet

(5) Side Slopes: Upstream 1.6H to 1.0V; Downstream 1.6H to 1.0V, lower part to 1.3H to 1.0V at top (See Sheet 3 of Appendix A for typical cross section)

(6) Zoning: Homogeneous - No Internal Drainage

(7) Impervious Core: None

(8) Cutoff: Mass Concrete Foundation (See Sec. 1.2G)

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: None

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway

I.1 Principal Spillway:

(1) Location: East Abutment

(2) Type: Three 12 inch diameter steel pipes embedded under depressed embankment.

I.2 Emergency Spillway:

(1) Location: East Abutment

(2) Type: Earth - Depressed Roadway section over primary spillway pipes.

J. Regulating Outlets:

A 2 inch diameter steel pipe is located in the embankment of approximately Sta. 2+25. This pipe was laid on top of the concrete dam and was installed to supply a flow for irrigation of plantings around the swimming pool area. The 4 inch diameter gate valve at the east abutment provides a means to increase flow from the lake area.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data exists for this dam. No documented maintenance or operation data exist to our knowledge. An engineering investigation (See Sheet 5 of Appendix A) was requested by the owner in 1966 to investigate the cause of seepage at the west abutment.

A. Surveys:

No detailed surveys have been made of the dam to our knowledge. The top of the center 12 inch pipe inlet at the east abutment was used for our site survey (Elevation 100.0). It is estimated that this site datum corresponds to a mean sea level elevation of about 1001.

B. Geology and Subsurface Materials:

The site is located in the border zone between the Ozarks and Western Plains geologic regions of Missouri. This area is characterized topographically by rolling to hilly with oak and hickory forest areas. The sedimentary rock layers exposed in the Ozarks region dip downward away from the Ozarks region and the higher and younger sedimentary deposits become the surface ledges in southwest Missouri. The soils in this area region are residual from cherty and dolomitic limestones of the Mississippian formations. Burlington limestones underlie the site. The rock is very weathered and pinnacled. The potential exists for sinkhole development, however according to the Department of Natural Resources there has not been any sinkhole problems in this area.

Soils in the area of the dam are one of this areas most common soils. The soils are clayey silts and silty clays with chert rock fragments. The chert is from the parent material and is found in each of the soil layers of this soil series. The soils are of the Crawford series. The first 2 horizons are low to moderately plastic silty clays. These soils are generally followed by a red to dark red silty clay of moderate to high plasticity. These soils generally make good fill material when properly compacted.

The "Geologic Map of Missouri" indicates that two known faults run in a northeast-southwesterly direction through or

very near the dam site. The Missouri Geological Survey has indicated that these faults are known as the Seneca faults and there is no known activity or movement. These faults in this area are generally considered to be inactive and have been for several hundred million years. The publication "Caves of Missouri" indicates there are four caves in Newton County and these are severeal miles from the dam site. Mr. Harrison indicated that there was a cave in the upper lake that the water leaked into.

C. Foundation and Embankment Design:

No design computations are available. Information from the previous owner indicates that the dam is composed of silty clays taken from the lake area upstream of the dam. The foundation of the embankment was continued upward from an existing concrete dam built a number of years prior. The extent of the concrete downward from the then existing groundline is unknown. The exposed dimensions of the concrete dam at the time of construction of this dam was 35 feet by 8 feet by 4 feet thick. No internal drainage features were incorporated, nor is there any apparent zoning of the embankment. No construction inspection records are available.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design data were obtained. Our analyses of the PMF are presented in Appendix C. These analyses were based on our field survey and observations, and estimates of areas and volumes from the U.S.G.S. quad sheet. It was concluded that the structure will pass 28 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

Appurtenant structures are the 2 inch diameter irrigation pipes and the three 12 inch diameter CMP's in the spillway. No design informatin is available. The upstream dam is also an appurtenant structure and is described in other sections.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION AND MAINTENANCE:

There are no operating records to our knowledge. The owner indicated that brush on the dam is cut every few years.

2.4 EVALUATION:

A. Availability:

The engineering data available are listed in Section 2.1.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

No valid engineering data on the design or construction of the embankment are available to our knowledge.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 20 June 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

John M. Healy-Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Steven L. Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
John Renner - Anderson Engineering, Inc. (Civil Engineer)

B. Dam:

The lower dam appears to be generally in good condition. No sloughing or obvious seepage through the relatively steep embankment was noted. Seepage was observed at the west abutment exiting along the sidewalk contact. The seepage was difficult to quantify but was estimated to be between 1 and 5 gpm. The dam was constructed on a slight curve which is concave to the downstream direction. The dam is relatively level across the crest and no surface cracking or unusual movement was obvious.

A border of trees, 6 to 10 inches in diameter, were on either side of the embankment crest. Small trees and medium to dense brush and bushes were noted on both faces of the embankment. The brush was more dense on the lower half of the downstream embankment. No erosion or animal burrows were noted, although some could exist in the areas of dense growth, which were not detected. The front face of the dam has riprap extending, in most areas, to or near the crest. The riprap appeared to be reasonably intact.

The upper dam also appeared to be in generally good condition. No sloughing or seepage through the very steep embankments were noted. The embankment at the crest is relatively level with no noted surface cracking or unusual movement.

Slight erosion was noted on the upstream side at west abutment spillway contacts and on the downstream side at the

east abutment contact of the upper dam. This erosion was from surface water from the adjacent drainage pattern along the road. No animal burrows were noted.

No instrumentation (monuments, piezometers, etc.) was observed.

The 5 inch diameter pipe in the swimming pool area at the base of the lower dam was discharging a full stream of water into the pool. Considerable sediment could be seen below the outlet of the 5 inch pipe. This granular material has apparently settled there over a period of time.

C. Appurtenant Structures:

C.1 Primary Spillway:

The approach to the spillway appears to be in good condition except for the trash fence which is sagging and pulled away from the support posts at some locations. The flow through the spillway pipes was restricted due to sedimentation at the inlet. The downstream channel is free of debris and vegetation. Some undermining of the concrete within the channel was observed.

C.2 Emergency Spillway:

The emergency spillway is located at the east abutment over the 3 primary spillway pipes. The section is part of a depressed section of the embankment.

D. Reservoir Area:

The slopes adjacent to the lake are moderately steep and no sloughing or serious erosion was noted. The watershed is basically open pasture like land with woods on the slopes surrounding the lake. The development of houses around the lake are widely spaced at this time.

E. Downstream Channel:

Flows from the spillways drop down into the swimming pool area. The flow is split with most going into the pool and the rest diverted around the east side of the pool in a ditch. The pool with concrete walls and miscellaneous concrete structures occupy the first 100 to 150 feet below the dam. Flows through the pool area then pass through a concrete box culvert under Highway K.

3.2 EVALUATION:

The effect of the trees that line the crest of the embankment should be evaluated to determine if they should be removed. Trees and brush on the upstream and downstream face of the embankment are potential seepage hazards and encourage animal burrows. The trash fence has failed. The seepage area at the west abutment contact, which was inspected in 1966 by W. R. Holway, should continue to be monitored and any change in flow or soil particles in the water should be immediately investigated by an engineer experienced in the design and construction of dams. The concrete lining in the spillway channel is undermined. The primary spillway pipes are clogged with debris.

Because the valve of the 2 inch diameter pipe is located on the downstream side of the dam, the full head of water impounded by the dam is acting entirely through the dam. The area around the pipe should be periodically inspected for seepage which might indicate a leak or rupture of the drain pipe which could eventually initiate a piping failure through the embankment.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam except for the 2 inch diameter irrigation pipe, which has not been used for many years. The spillway is uncontrolled, so that the pool is normally controlled by spring flow and evaporation. The upper lake also with an uncontrolled spillway, is controlled by a cave or sink as well as rainfall, runoff, and evaporation.

4.2 MAINTENANCE OF DAM:

The crest of the dam is kept mowed and the owner indicated that the brush and trees on the slopes are cut every few years.

4.3 MAINTENANCE OF OPERATING FACILITIES:

It is not known if the 2 inch diameter pipe and valve are regularly maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Vegetation on the dam should be cut annually. Deteriorated areas in the spillway should be corrected and maintained. The seepage area at the west abutment contact should be monitored on a regular basis. The dam should be periodically inspected to detect possible seepage under or through the embankment.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field check of spillway dimensions and embankment elevations; and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. No previous hydraulic or hydrologic studies were obtained. Our hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

The trash fence in the approach to the spillway at the east abutment should be repaired. All debris and sedimentation at the inlet to the spillway pipes should be removed. The downstream spillway concrete lining is undermined and broken and it should be removed and replaced.

The spillway pipes at the west abutment of the upper dam should be cleaned out and a drainage ditch constructed to insure that debris does not block the inlets.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillways will pass 28 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief Engineers, require that this structure (small size with high downstream potential pass 50 percent to 100 percent of the PMF, without overtopping. Considering that 15 dwellings lie within the damage zone, the PMF has been determined to be the appropriate spillway design flood. The structure will pass a 100-year frequency flood without overtopping.

The routing of the PMF through the spillways and dam indicate that the dam will be overtopped by 1.75 ft. at elevation 105.25. The duration of the overtopping will be 5 hours and the maximum outflow will be 2579 cfs. The maximum

discharge capacity of the spillway is 443 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Visual observations which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The inspection team is not aware of any post-construction changes to the dam after the final phase was completed in 1957.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition however the excessively steep slopes make it imperative that seepage and stability analysis be carried out as soon as possible. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) brush and small trees on the upstream and downstream face of the dam; (2) a border of trees on either side of the crest; (3) seepage at the west abutment contact; (4) concrete in the spillway channel is broken and undermined; (5) trash fence in entrance to primary spillway has failed; (6) primary spillway pipes are clogged with debris. Another deficiency was the lack of seepage and stability analysis records.

The dam will be overtopped by flows in excess of 28 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the defici-

encies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. Priority should be given to repairing and increasing the size of the spillways.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

(1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

(2) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(3) Brush and tree growth should be removed from the dam. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam. The border of trees on the crest of the dam should be evaluated by an engineer to determine if they should be removed.

(4) The seepage area of the west abutment contact should be monitored on a regular basis. If the quantity of flow changes or if soil particles begin to be carried by the water from the seep, an engineer experienced in the de-

sign and construction of dams should be immediately retained to evaluate the situation.

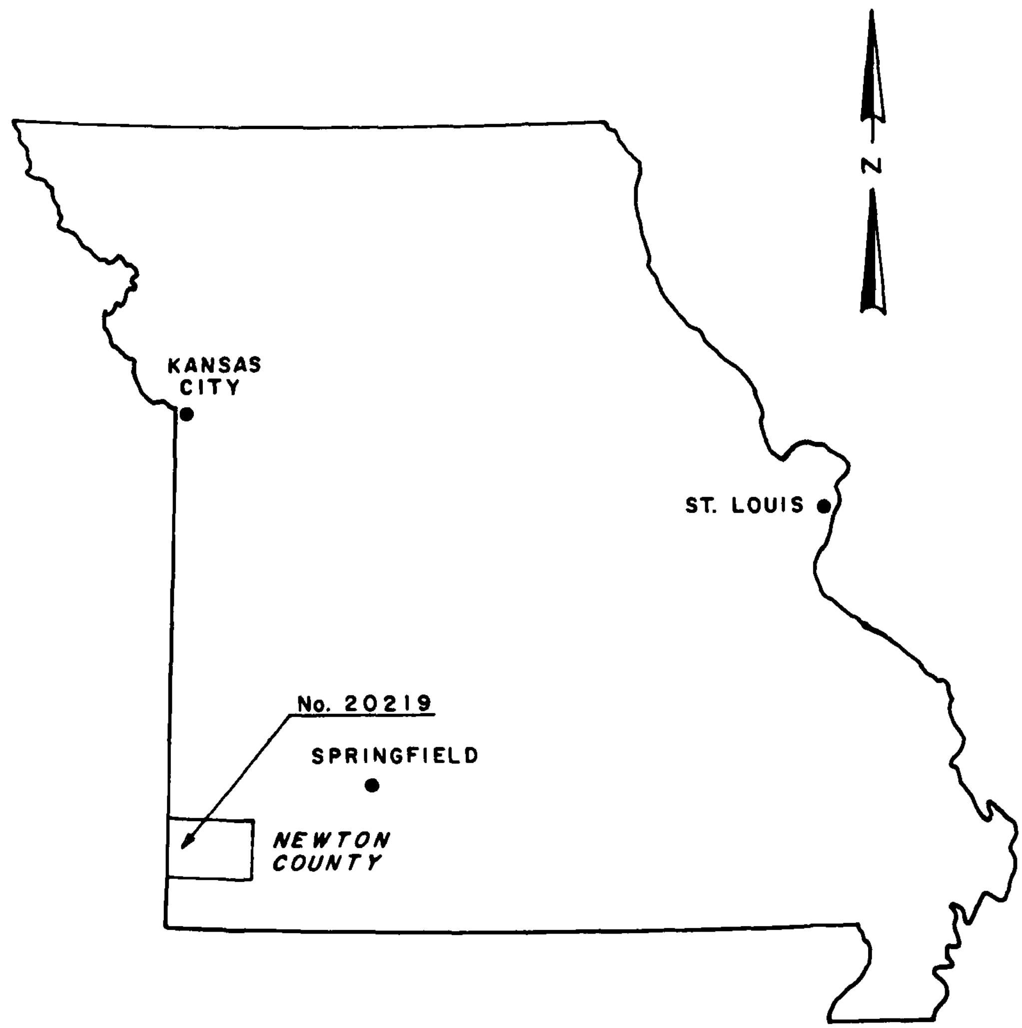
(5) The concrete lining in the spillway discharge channel should be repaired and replaced.

(6) The trash fence at the entrance to the primary spillway should be repaired.

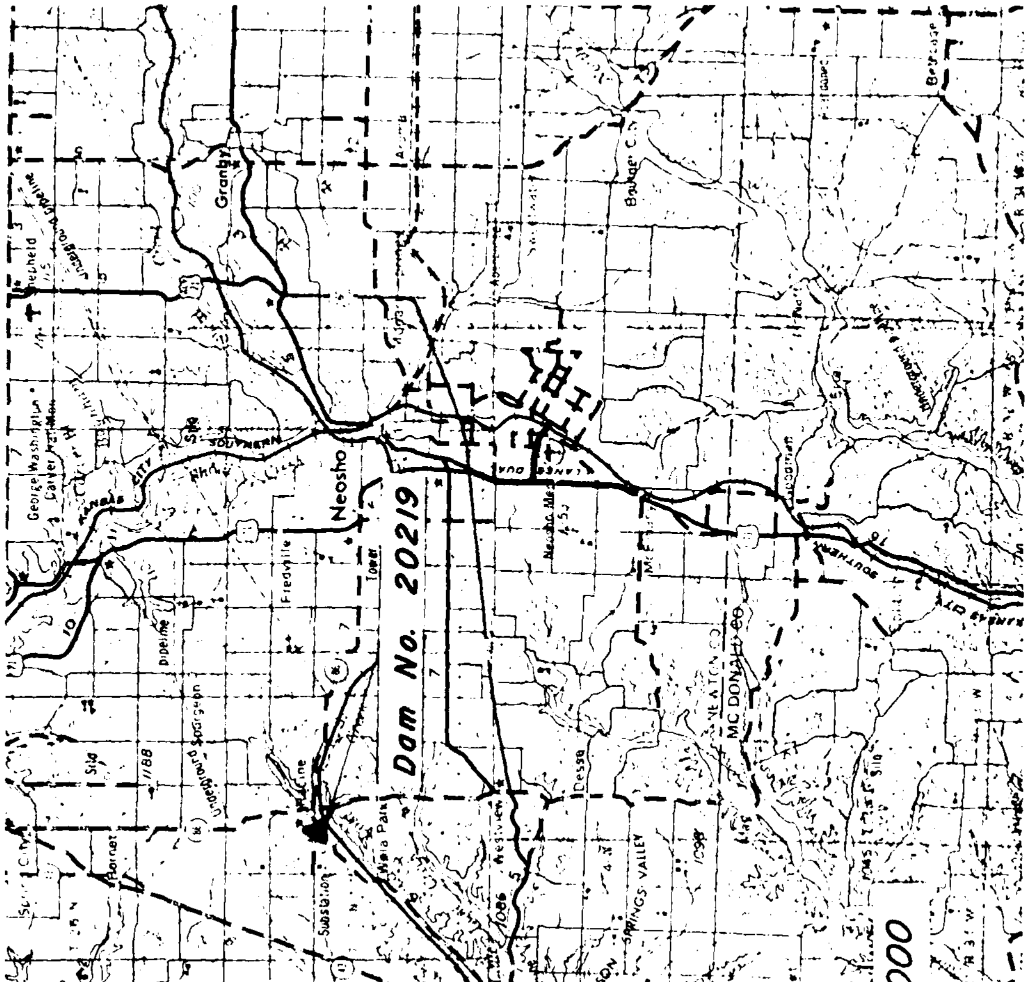
(7) The primary spillway pipes should be cleared and cleaned on a regular basis.

(8) A detailed inspection of the dam should be made periodically by an engineer experience in the design and construction of dams.

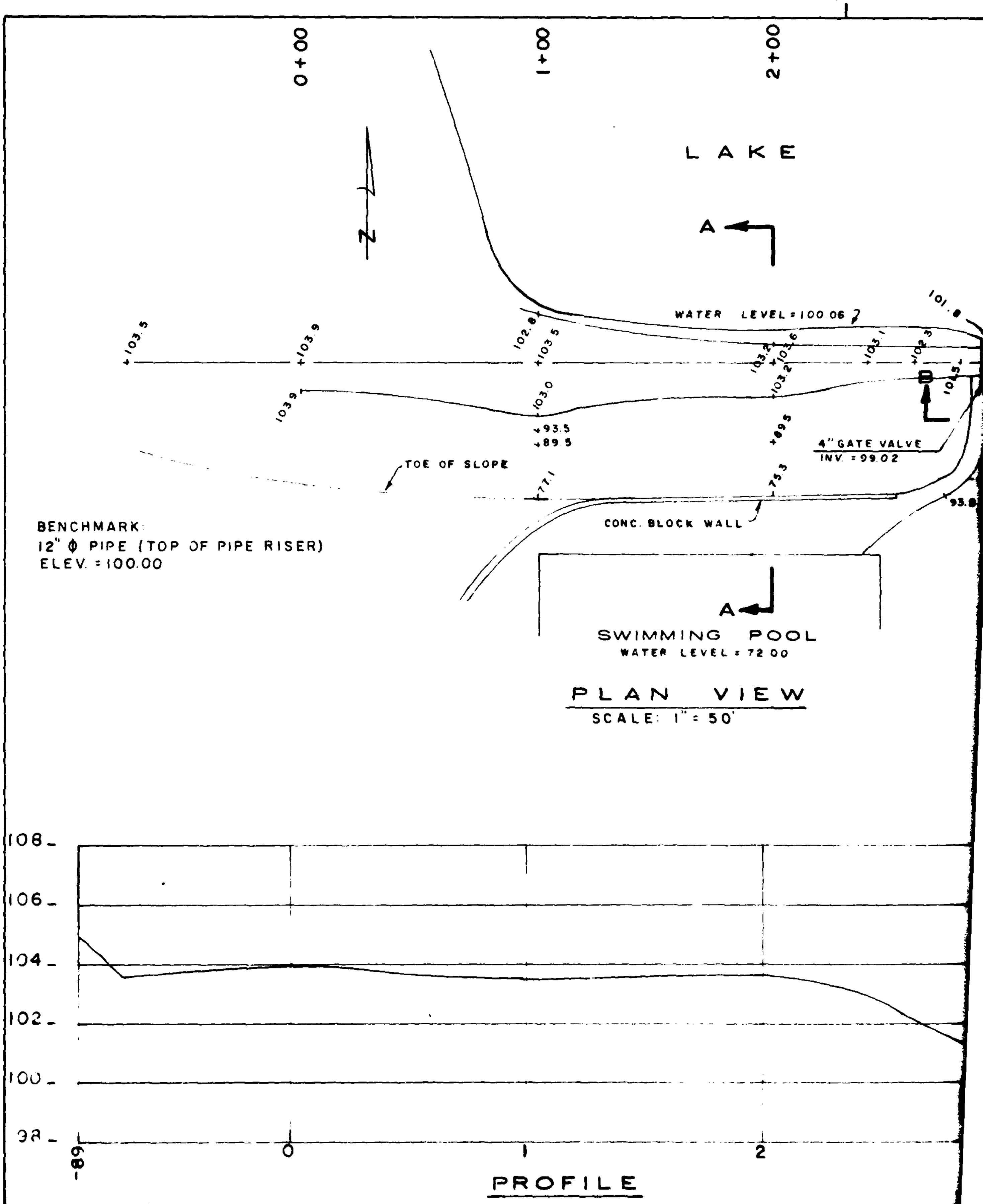
APPENDIX A

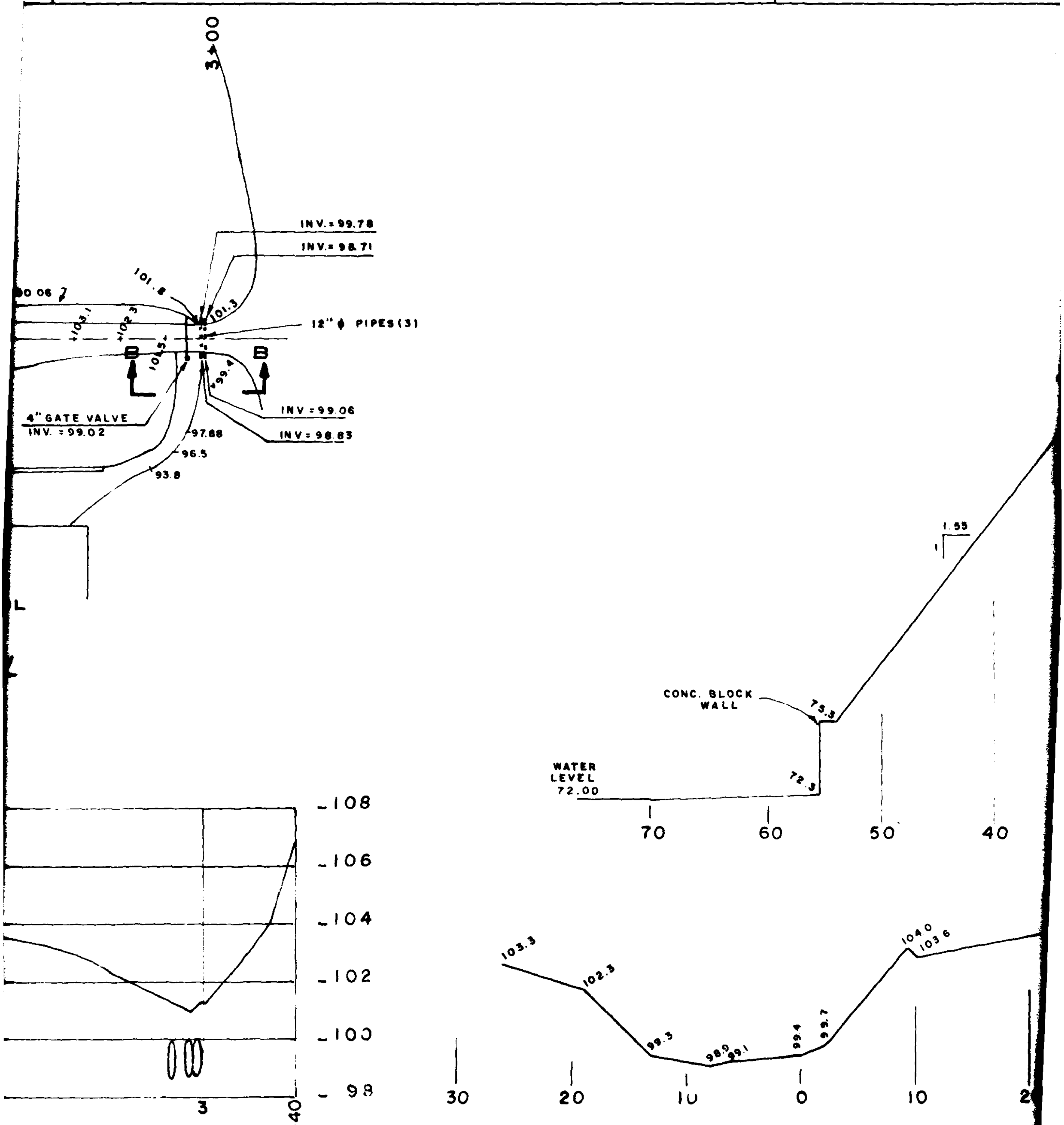


LOCATION MAP



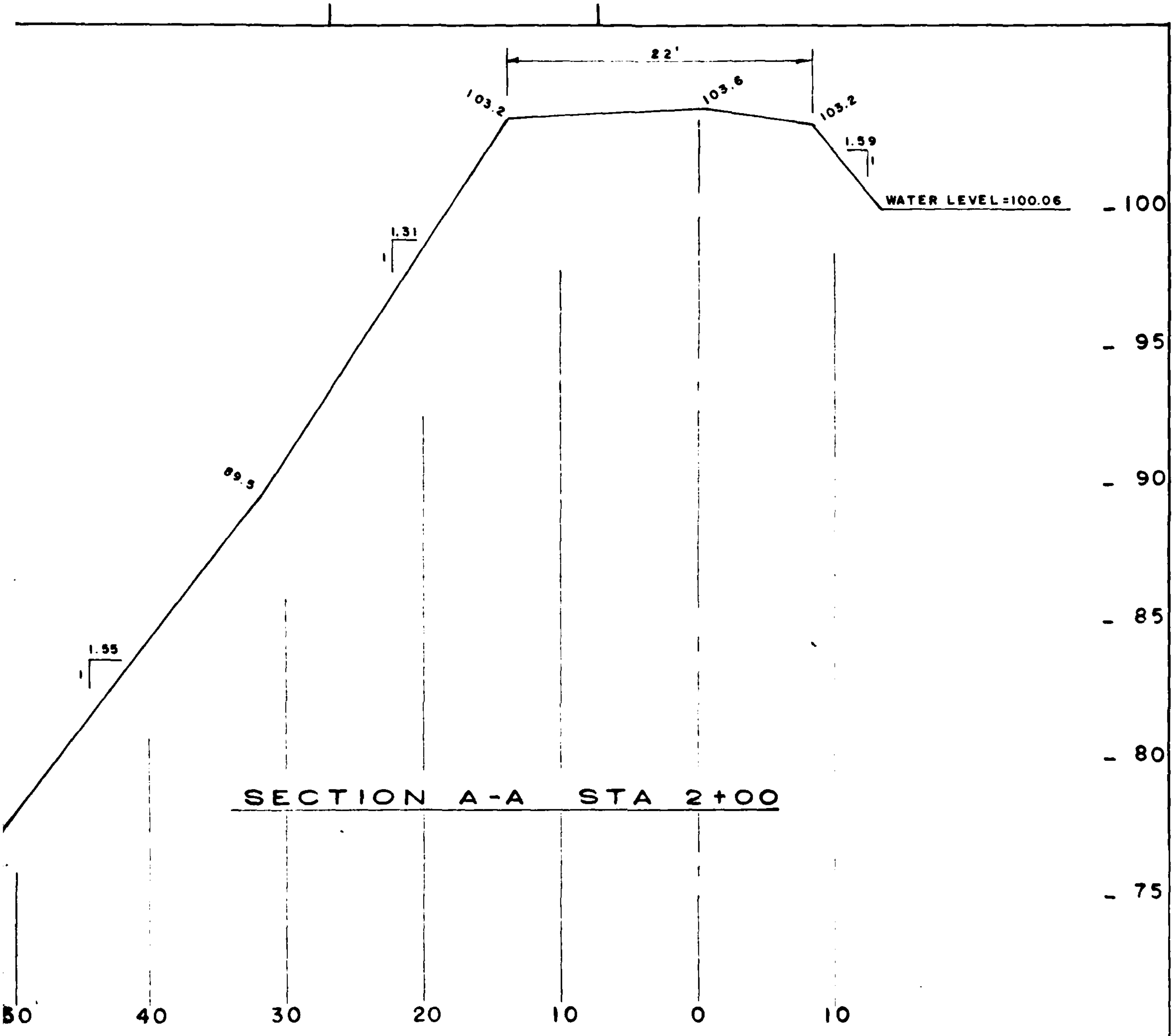
SITE VICINITY MAP

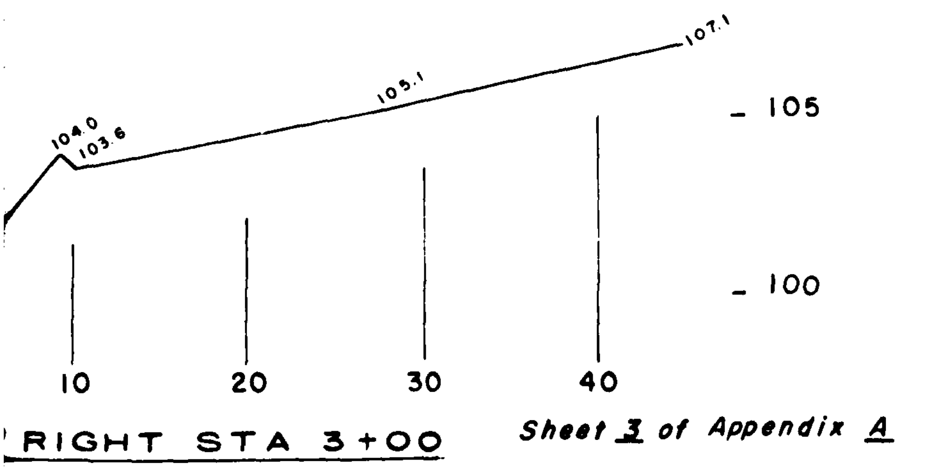

0+00
1+00
2+00
LAKE
N
A
WATER LEVEL = 100.06
+103.5
+103.9
102.8
+103.5
103.2
+103.6
103.2
+103.1
+102.3
101.8
104.5
B
1039
103.0
+93.5
+89.5
+89.5
4" GATE VALVE
INV. = 99.02
TOE OF SLOPE
77.1
75.3
93.8
CONC. BLOCK WALL
BENCHMARK:
12" ϕ PIPE (TOP OF PIPE RISER)
ELEV. = 100.00
A
SWIMMING POOL
WATER LEVEL = 72.00
PLAN VIEW
SCALE: 1" = 50'
108
106
104
102
100
98
-89
0
1
2
PROFILE



SECTION B-B 20' RIGHT ST

1 2





Sheet 3 of Appendix A

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

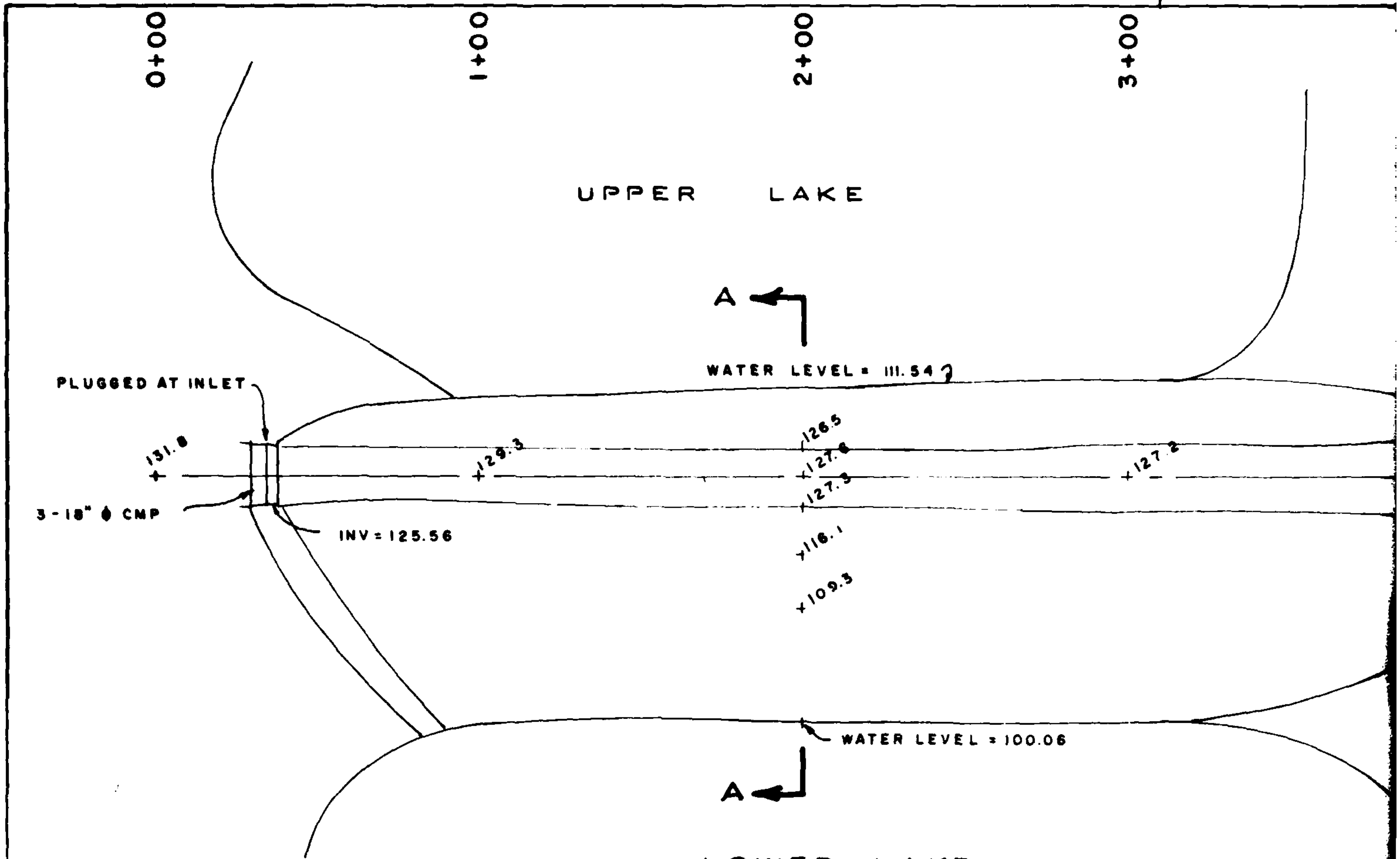
AUSTIN HARRISON LAKE

MO. No. 20219

PLAN & PROFILE

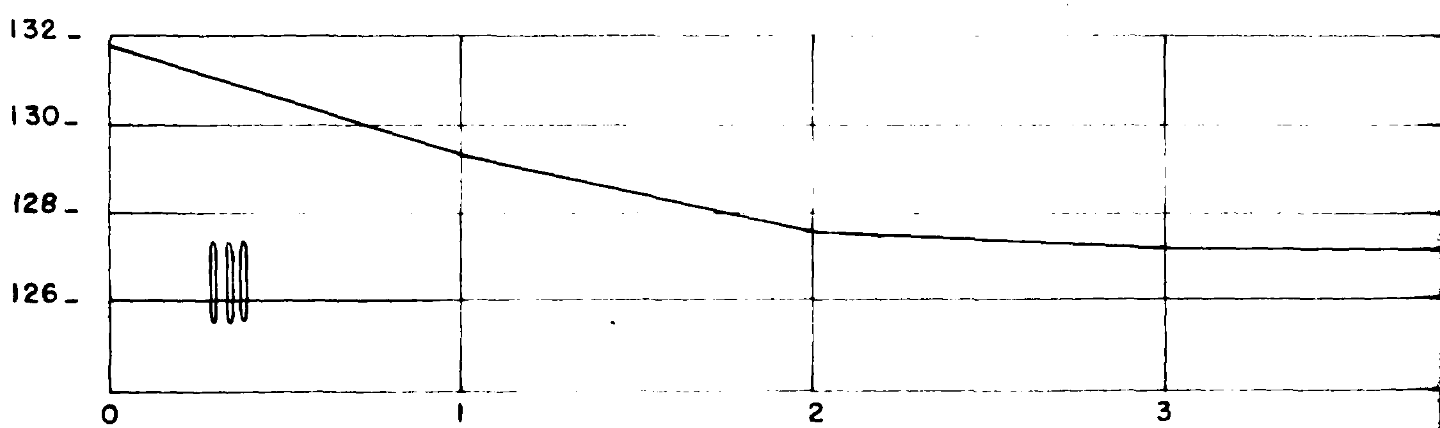
NEWTON COUNTY, MO.

13

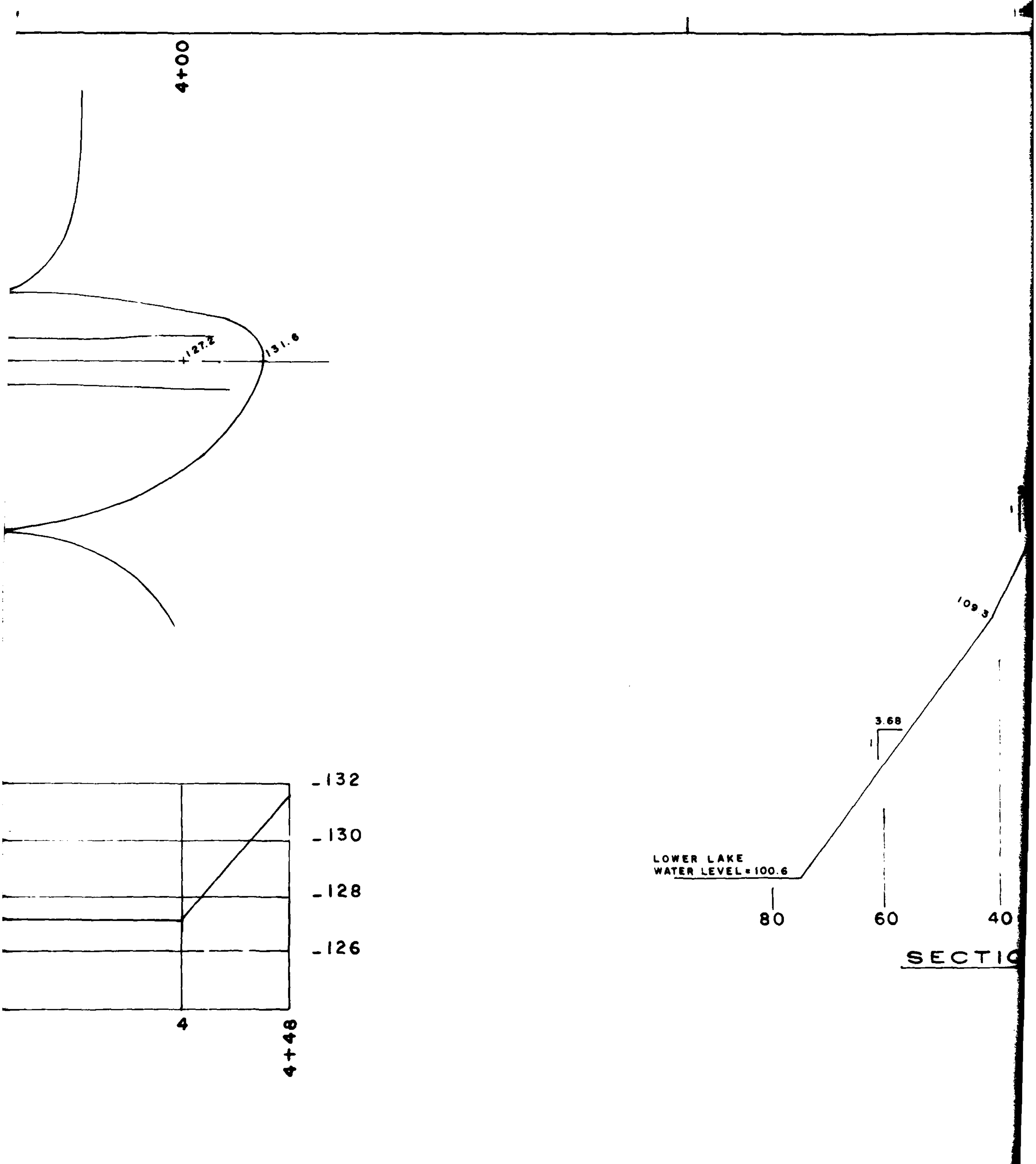


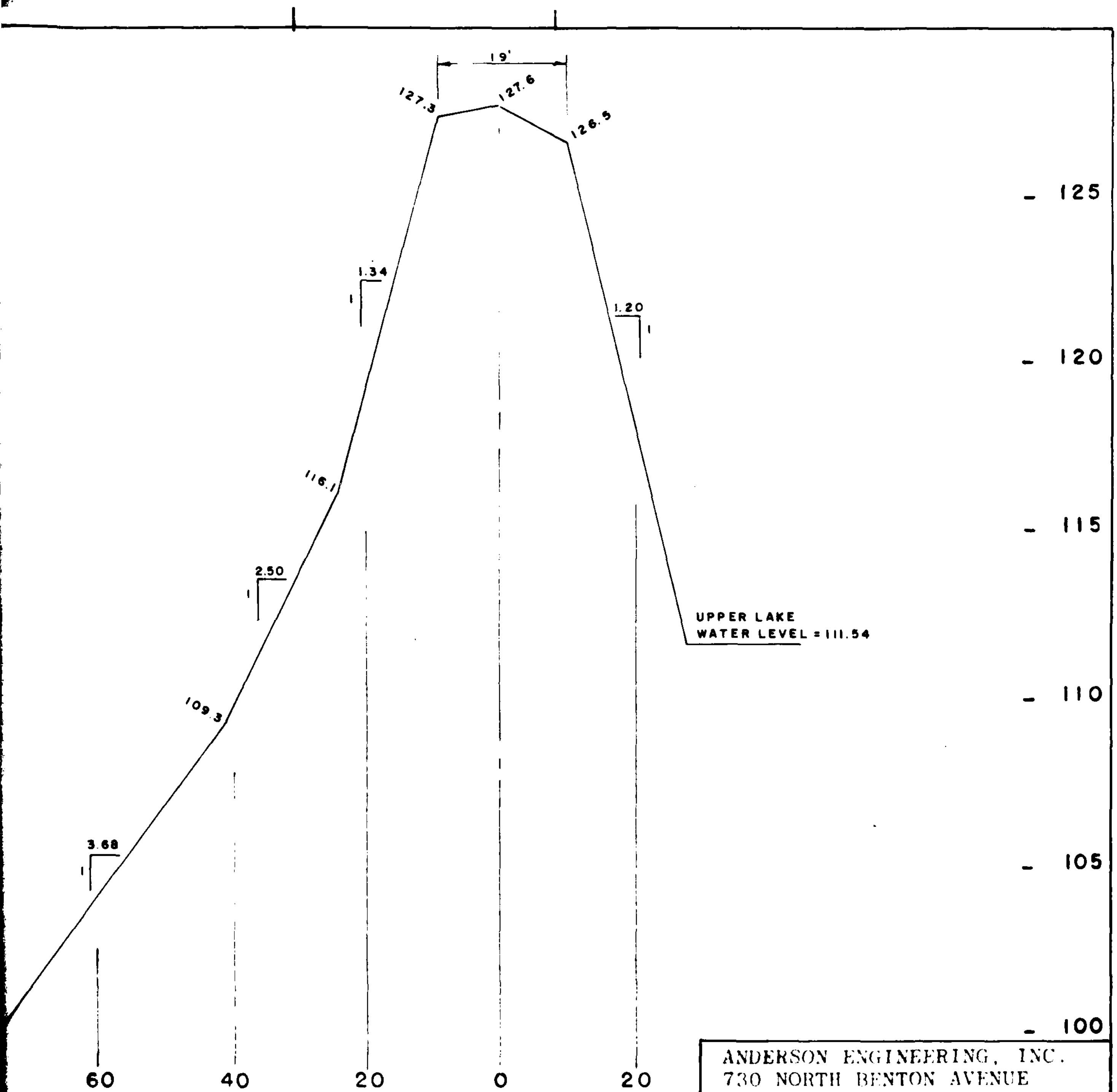
PLAN VIEW

SCALE: 1" = 50'



PROFILE


4+00
127.2
131.6
109.3
3.68
1
LOWER LAKE
WATER LEVEL = 100.6
80
60
40
SECTIO
132
130
128
126
4
4+48



SECTION A-A STA 2+00

Sheet 4 of Appendix A

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

AUSTIN HARRISON LAKE
UPPER LAKE

PLAN & PROFILE

NEWTON COUNTY, MO.

1 3

October 27, 1966

Mr. Thomas J. Cusack
Suite 210
Miners Bank Building
Joplin, Missouri

Re: Racine Dam

Dear Mr. Cusack:

At your request, I visited your dam just west of Racine on October 25, 1966. I examined the dam carefully and noted the water leaving the dam on the west abutment. We were told that for several years water had been coming out from this same location. The water was running absolutely clear and was not carrying any material from the dam with it.

It is my judgment that the water is not passing through the earthen dam but is getting through the foundation of the dam in probably the top layers of the rock. If saving of the water is important, this leakage can, in all probability, be stopped or cut down to a minimum by drilling through the dam into the foundation rock and grouting to fill up the crevices and cracks in the rock of the west abutment.

It is my professional opinion that there is no danger of erosion of the dam from this leakage.

Very truly yours,

W. R. Holway and Associates, Inc.

W. R. Holway

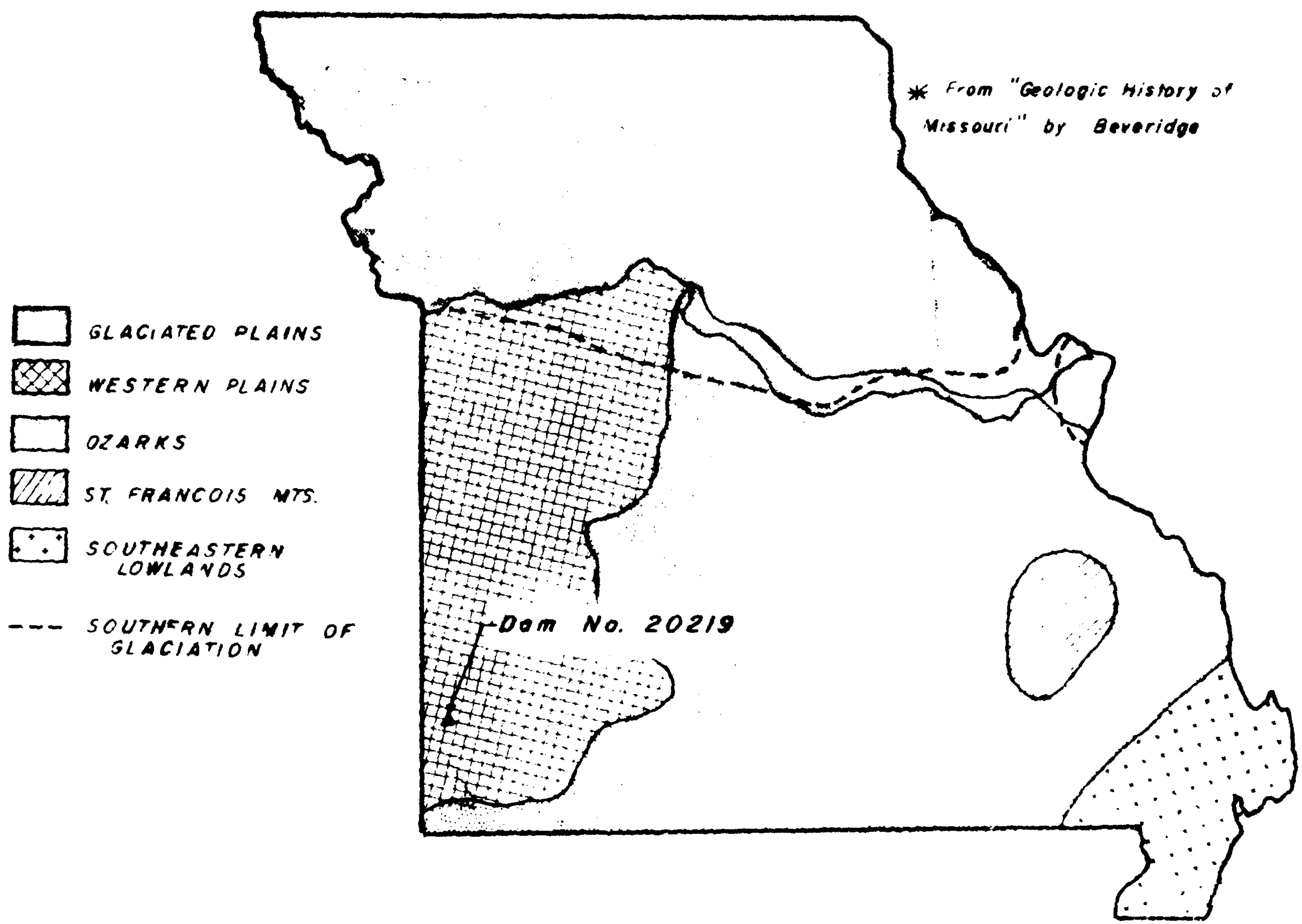
WRH:em

SHEET 5 OF APPENDIX A

P0115
#2

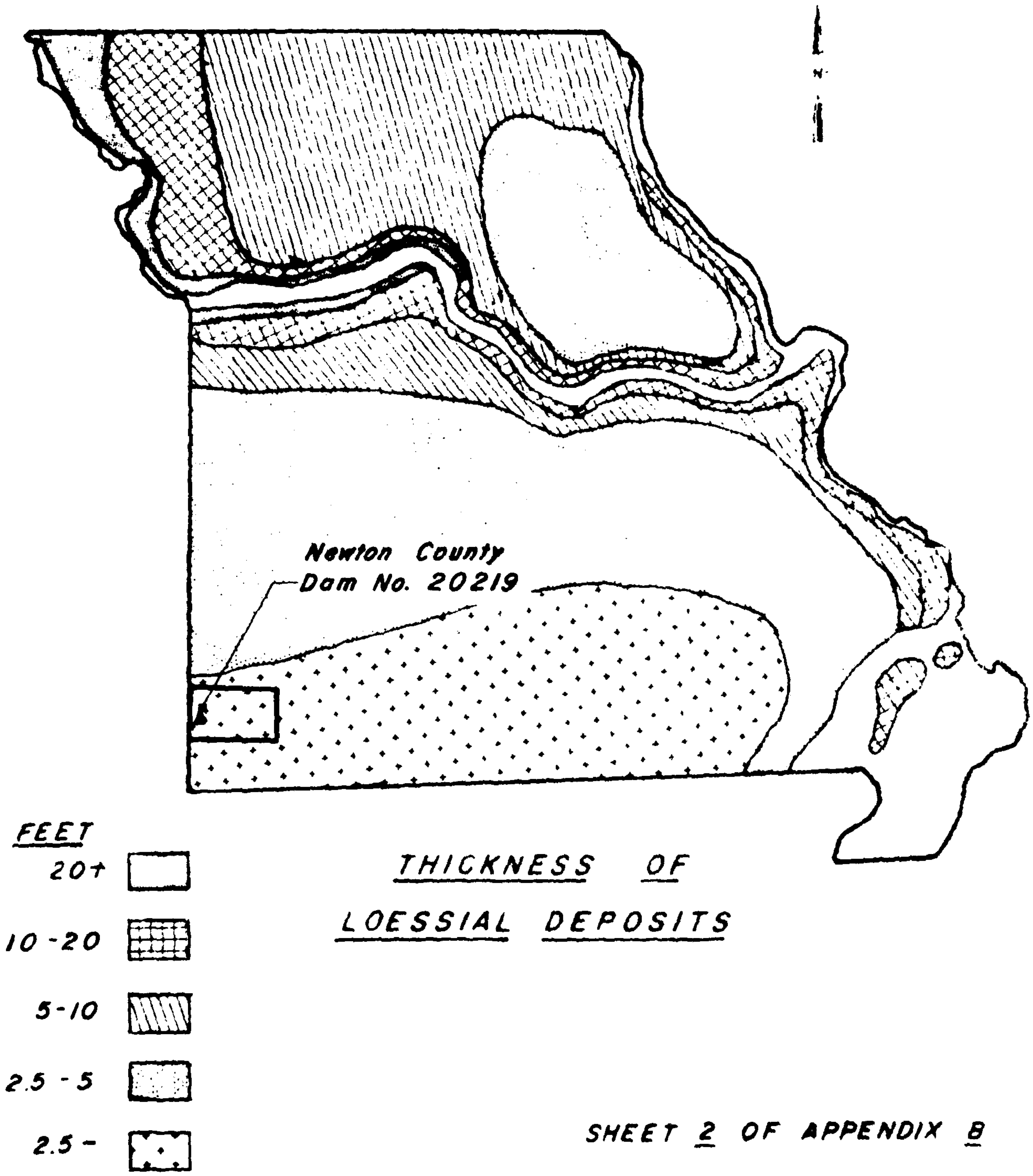
APPENDIX B

MAJOR GEOLOGIC REGIONS OF MISSOURI



SHEET 1 OF APPENDIX B

* From "Soils of Missouri"

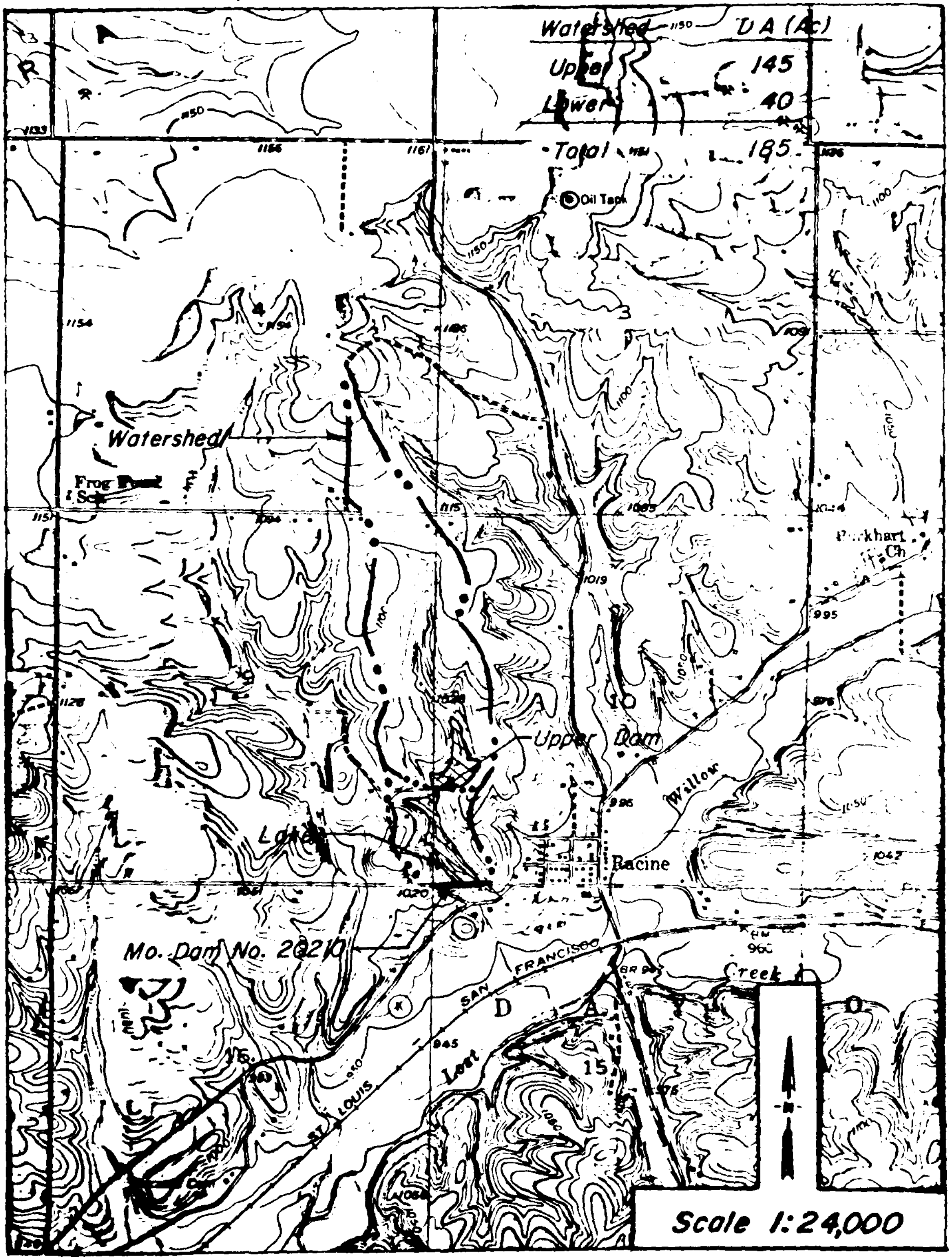


THICKNESS OF LOESSIAL DEPOSITS

SHEET 2 OF APPENDIX B

APPENDIX C

From Racine, Mo.- Okla.- Kans. 7.5' Quad



LAKE AND WATERSHED MAP

Sheet 1 Appendix C

HYDRAULICS AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. Mr. Austin Harrison has indicated that the lake level has been to within 6 inches of the top of the dam. Mr. Harrison also indicated that the dam has not been overtopped.

Visual Inspection: At the time of inspection, the pool level was approximately 1.06 feet above normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by a planimeter-from the U.S.G.S. Racine, Missouri, Oklahoma-Kansas 7.5 minute quadrangle map. The storage volume was developed from this data. A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 887 c.f.s. and a time to peak of 4 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 2806 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 11102-1411.

Based on our analyses, the combined spillways will pass 28 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering that 15 dwellings lie with the damage zone, the PMF has been determined to be the appropriate spillway design flood.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.75 ft. at elevation 105.25. The duration of the overtopping will be 5 hours, and the maximum outflow will be 2579 c.f.s. The maximum discharge capacity of the combined spillways is 443 c.f.s. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam. The computer input, output and hydrographs for the PMF are presented on Sheets 6, 7A, 7B, and 8 of Appendix C.

There is an existing dam upstream of Austin Harrison Dam. To obtain more realistic results of the flood routing studies, the PMF was considered acting simultaneously over the entire watershed area of the two dams. First, the PMF was routed through the upper reservoir and spillway (See lake and watershed map, Sheet 1 Appendix C) then the outflow hydrograph from this dam was combined with the inflow hydrograph from the watershed of Austin Harrison Dam and routed through the lower reservoir and spillway structures. The assumed beginning water levels used for routing was at the primary spillway crest.

OVERTOPPING ANALYSIS FOR AUSTIN HARRISON DAM

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
   Hydraulic Inputs Are as Follows:

   a. Twenty-four Hour Rainfall of 27.3 Inches for 200 Square Miles - All Season Envelope

   b. Drainage Area = 40 Acres; = .06 Square Miles

   c. Travel Time of Runoff .04 Hrs.; Lag Time 0.2 Hrs.

   d. Soil Conservation Service Soil Group B

   e. Soil Conservation Service Runoff Curve No. 75 (AMC III)

   f. Proportion of Drainage Basin Impervious .25

2. Spillways

   a. Primary Spillway: Three 12 inch steel pipes (one of them with a 4 inch gate valve)

   b. Emergency Spillway:

      Length Varies; Side Slopes 20H:lv & 12H:1V; C = 2.7

   c. Dam Overflow

      Length 210 Ft.; Crest Elev. 103.5; C = 3.0

3. Spillway and Dam Rating:

   Curve Prepared by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards.
   Equation Used for Spillway: 12" pipe - pipe charts with inlet control.
   Emergency Spillway - $Q = CLH^{1.5}$

Note: Time of Concentration From Equation $Tc = \frac{(11.9\ L^3)^{.385}}{(H)^{.385}}$

California Culvert Practice, California Highways and Public Works, Sept. 1942.

* Similar data was developed for the upper dam.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph

   a. Peak - 887 c.f.s.

   b. Time to Peak 4 Min.

2. Flood Routings Were Computed by the Modified Puls Method

   a. Peak Inflow

      50% PMF 1372 c.f.s.; 100% PMF 2806 c.f.s.

   b. Peak Elevation

      50% PMF 104.31; 100% PMF 105.25

   c. Portion of PMF That Will Reach Top of Dam

      28%; Top of Dam Elev. 103.5 Ft.

3. Computer Input and Output Data are shown on Sheets 6 & 7 of this Appendix.

```
A       OVERTOPPING ANALYSIS FOR AUSTIN HARRISON DAM ( B 03 )
A       STATE ID NO. 20219  CO. NO. 145  CO. NAME NEWTON
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 79511
B     300               5
B1      5
J       1       7       1
J1    .15     .20     .30     .40     .50     .75     1.0
K       0       1                               3       1
K1      INFLOW HYDROGRAPH COMPUTATION  FROM THE UPPER LAKE
M       1       2    0.23            0.23       1                       1
P       0    27.3     102     120     130
T                                                      -1     -75            0.05
W2   0.37    0.22
X       0     -.1       2
K       1       2                       0       4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE  UPPER LAKE
Y                               1       1
Y1      1                                              62      -1
Y4 125.6   126.6   127.6   128.6   129.6   130.6
Y5      0       6      12      15      20      22
$A      0       7     8.3     9.5
$E     99   125.6     128     130
$S  125.6
$D  127.2     3.0     1.5     240
K       0       3                               3       1
K1      INFLOW HYDROGRAPH COMPUTATION FOR AUSTIN HARRISON DAM
M       1       2    0.06            0.06       1                       1
P       0    27.3     102     120     130
T                                                      -1     -75            0.25
W2   0.04    0.02
X       0     -.1       2
K       2       3                       0       3       1
K1      COMBINE ROUTING AND LOCAL INFLOW AT AUSTIN HARRISON DAM
K       1       4                       0       4       1
K1     RESERVOIR ROUTING BY MODIFIED PULS AT AUSTIN HARRISON DAM
Y                               1       1
Y1      1                                              90      -1
Y4     99     101     102     103   103.5     104     105     106
Y5      0       8      60     314     443     600     960    1425
$A      0      10      14      16
$E     72      99   103.5     105
$S     99
$D  103.5     3.0     1.5     210
K      99
```

P.M.F. INPUT DATA

SHEET 6 APPENDIX C

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 0.15	RATIO 2 0.20	RATIO 3 0.30	RATIO 4 0.40	RATIO 5 0.50	RATIO 6 0.75	RATIO 7 1.00
				RATIOS APPLIED TO FLOWS						
HYDROGRAPH AT	1	0.23	1	397.	529.	794.	1058.	1323.	1984.	2645.
	(	0.60)	(	11.24)(	14.98)(	22.47)(	29.96)(	37.45)(	56.18)(	74.90)(
ROUTED TO	2	0.23	1	337.	458.	707.	959.	1212.	1848.	2486.
	(	0.60)	(	9.54)(	12.97)(	20.02)(	27.15)(	34.31)(	52.32)(	70.39)(
HYDROGRAPH AT	3	0.06	1	179.	239.	359.	478.	598.	896.	1195.
	(	0.16)	(	5.08)(	6.77)(	10.15)(	13.54)(	16.92)(	25.38)(	33.84)(
2 COMBINED	3	0.29	1	383.	522.	803.	1087.	1372.	2088.	2806.
	(	0.75)	(	10.85)(	14.78)(	22.74)(	30.78)(	38.85)(	59.13)(	79.46)(
ROUTED TO	4	0.29	1	122.	266.	528.	870.	1171.	1884.	2579.
	(	0.75)	(	3.46)(	7.53)(	14.96)(	24.64)(	33.17)(	53.34)(	73.03)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	125.57	125.60	127.20
STORAGE	62.	62.	74.
OUTFLOW	0.	0.	10.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.15	127.79	0.59	79.	337.	6.83	15.92	0.00
0.20	127.93	0.73	80.	458.	8.25	15.83	0.00
0.30	128.18	0.98	82.	707.	12.50	15.83	0.00
0.40	128.40	1.20	84.	959.	13.50	15.83	0.00
0.50	128.60	1.40	86.	1212.	14.50	15.83	0.00
0.75	129.06	1.86	90.	1848.	15.75	15.83	0.00
1.00	129.47	2.27	93.	2486.	16.42	15.83	0.00

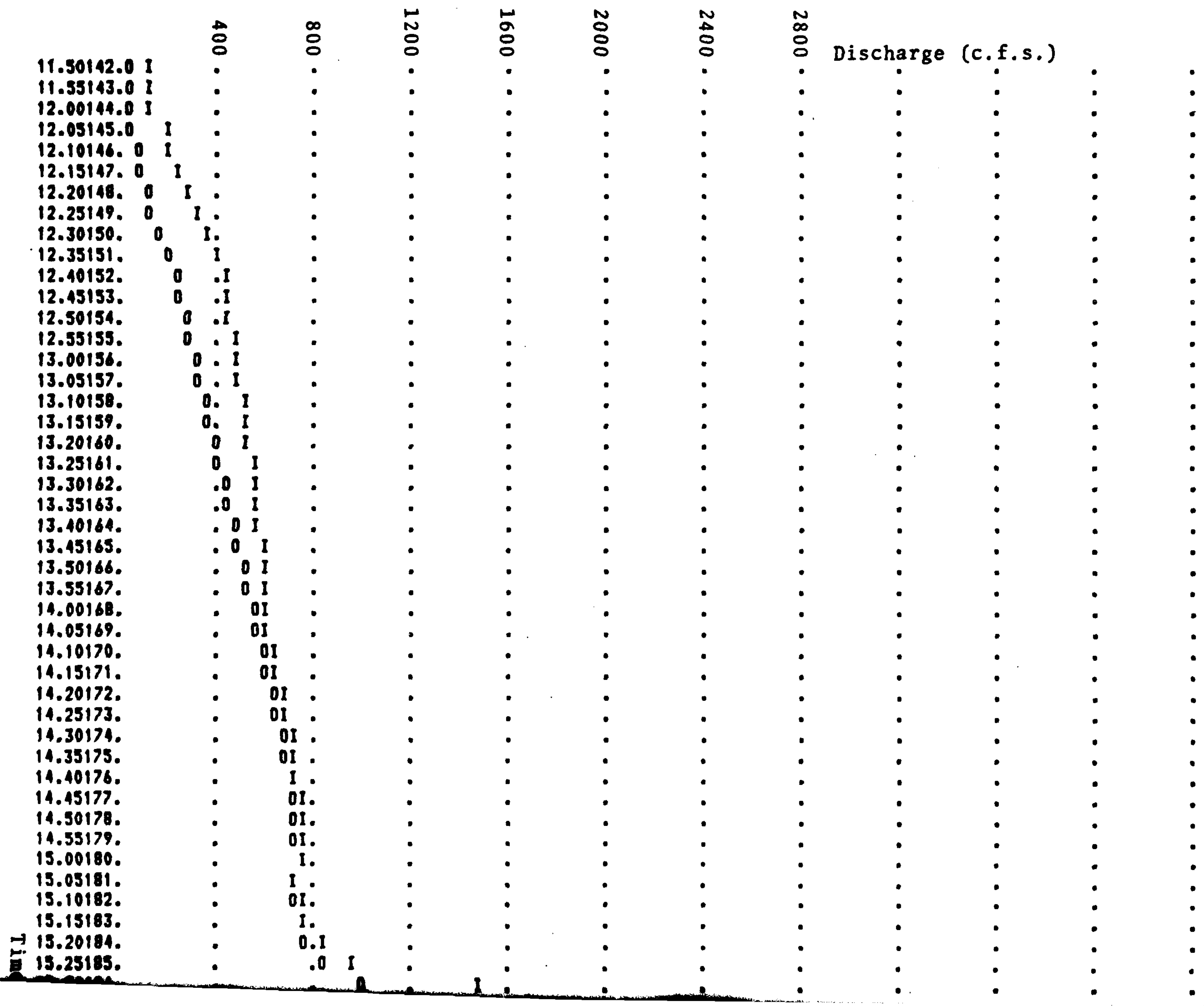
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	99.00	99.00	103.50
STORAGE	90.	90.	144.
OUTFLOW	0.	0.	443.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.15	102.24	0.00	127.	122.	0.00	16.67	0.00
0.20	102.81	0.00	134.	266.	0.00	16.25	0.00
0.30	103.65	0.15	146.	528.	0.42	16.08	0.00
0.40	104.05	0.55	152.	870.	0.92	16.00	0.00
0.50	104.31	0.81	156.	1171.	1.33	16.00	0.00
0.75	104.84	1.34	164.	1884.	3.58	15.92	0.00
1.00	105.25	1.75	170.	2579.	5.00	15.92	0.00

P.M.F. OUTPUT DATA



Discharge (c.f.s.)
400
800
1200
1600
2000
2400
2800
Time
11.50142.0
11.55143.0
12.00144.0
12.05145.0
12.10146.
12.15147.
12.20148.
12.25149.
12.30150.
12.35151.
12.40152.
12.45153.
12.50154.
12.55155.
13.00156.
13.05157.
13.10158.
13.15159.
13.20160.
13.25161.
13.30162.
13.35163.
13.40164.
13.45165.
13.50166.
13.55167.
14.00168.
14.05169.
14.10170.
14.15171.
14.20172.
14.25173.
14.30174.
14.35175.
14.40176.
14.45177.
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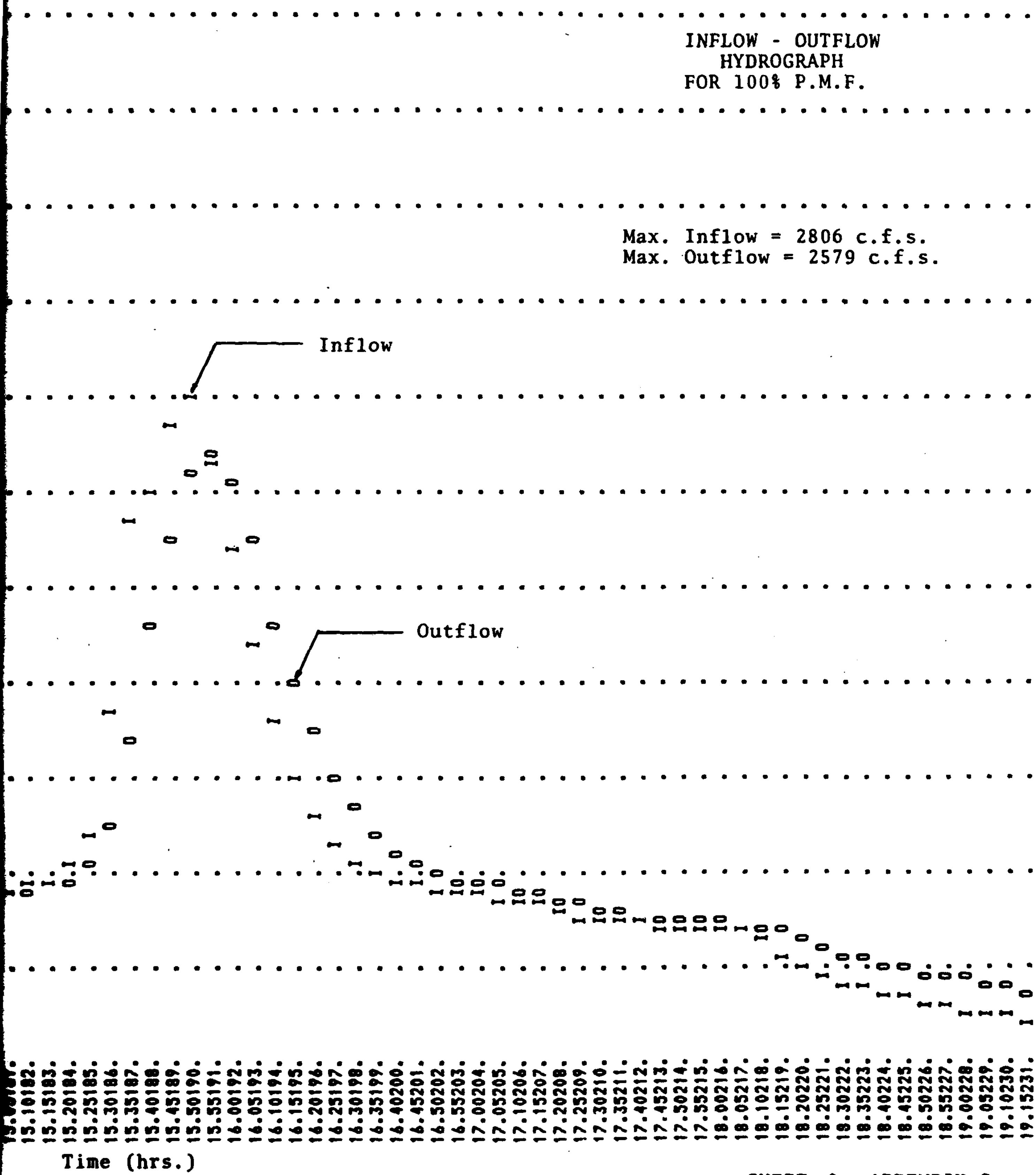
15.20184.
15.25185.


INFLOW - OUTFLOW
HYDROGRAPH
FOR 100% P.M.F.
Max. Inflow = 2806 c.f.s.
Max. Outflow = 2579 c.f.s.
Inflow
Outflow
Time (hrs.)

APPENDIX D

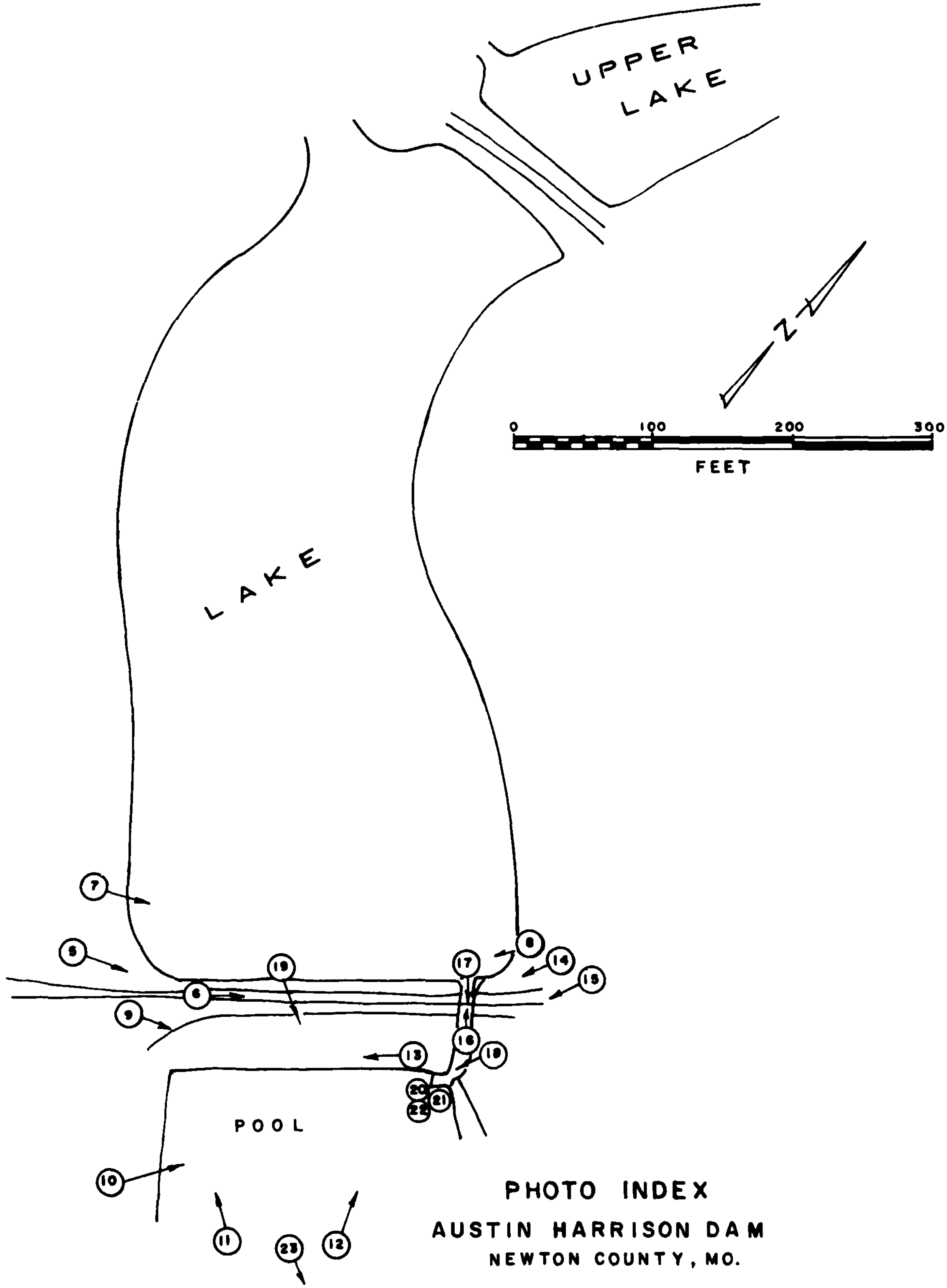
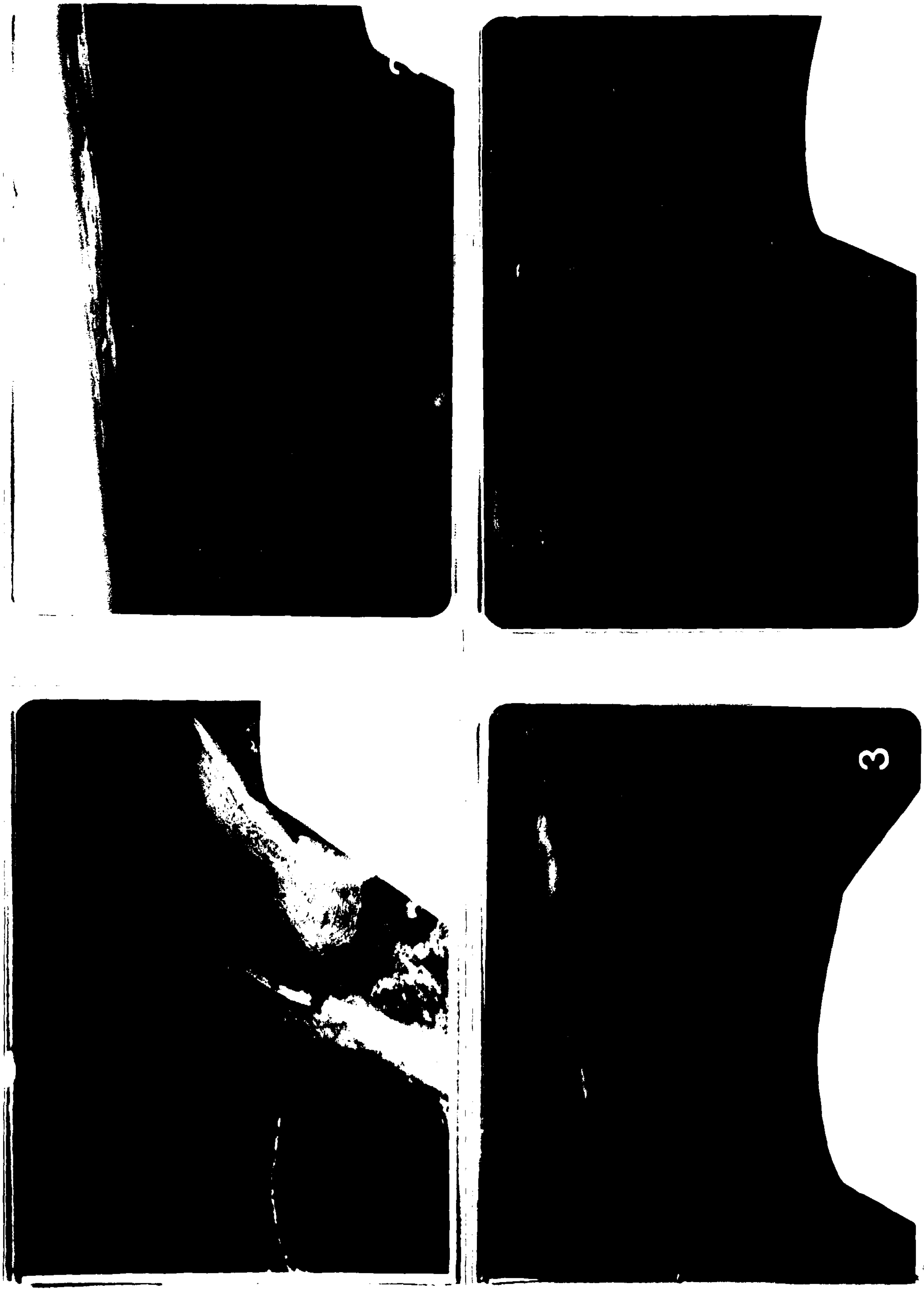


PHOTO INDEX
AUSTIN HARRISON DAM
NEWTON COUNTY, MO.

Sheet 1 of Appendix D

LIST OF PHOTOGRAPHS

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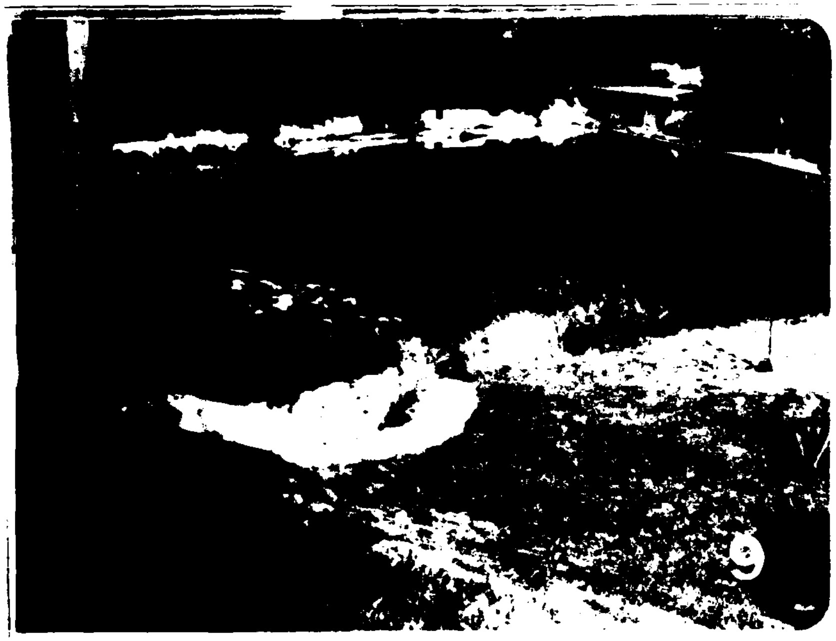
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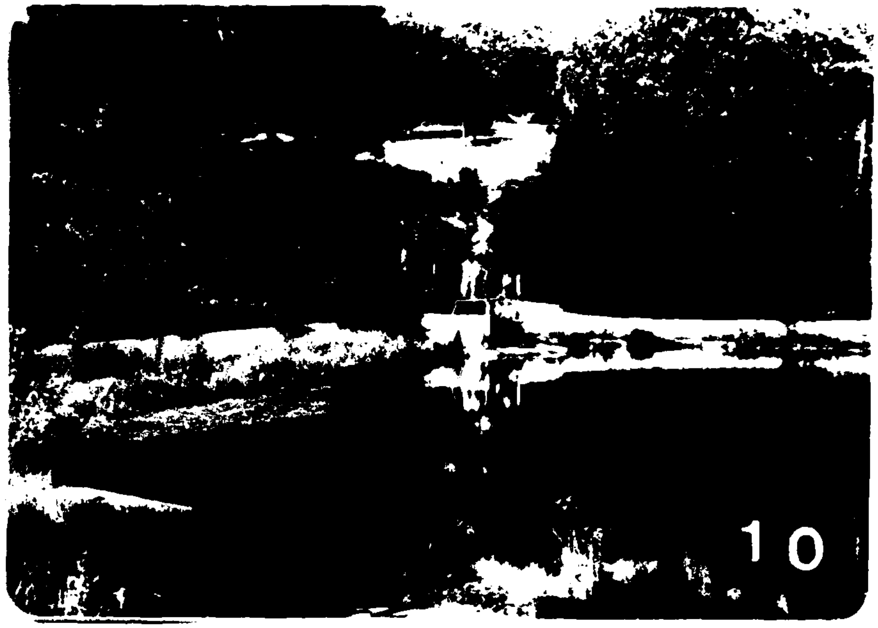
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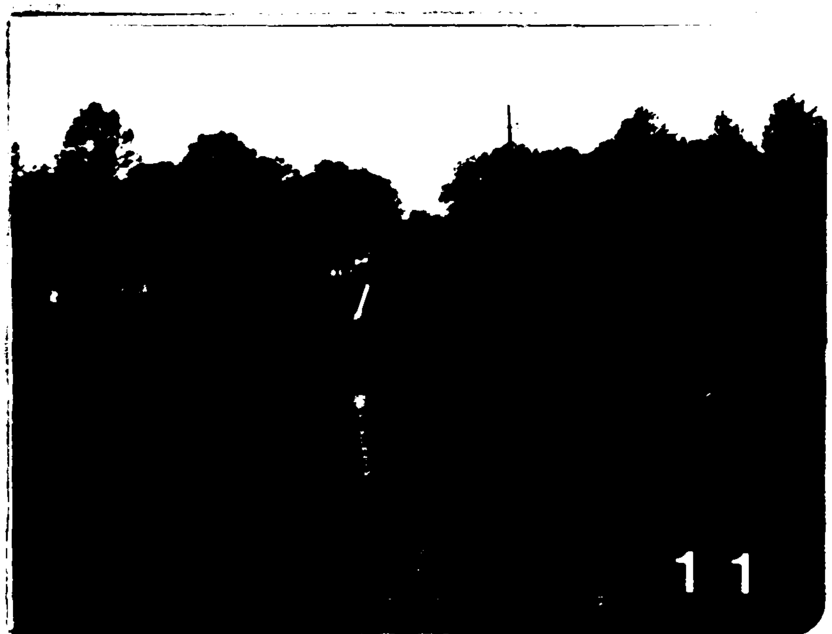
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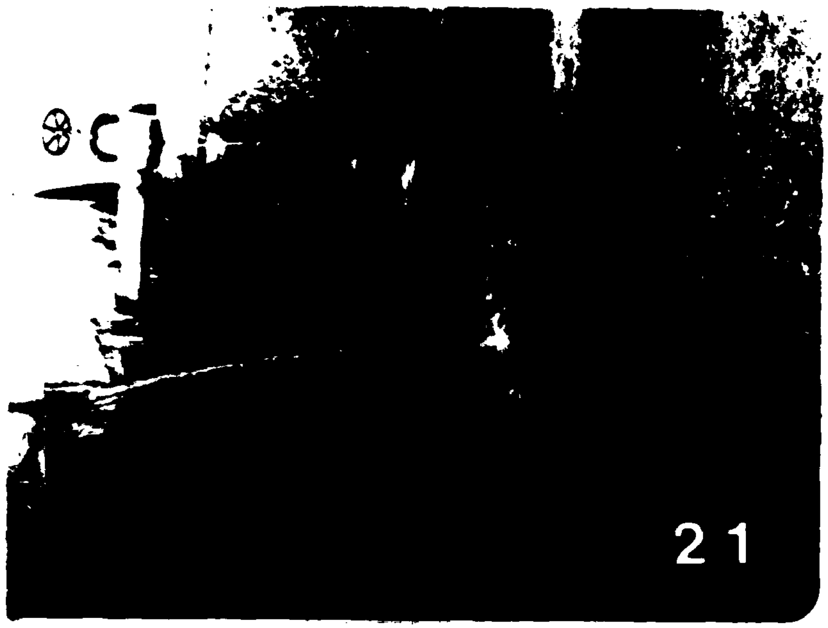
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